Application
for
United States Letters Patent

To all whom it may concern:

Be it known that

Yaakov Naparstek

have invented certain new and useful improvements in

PEPTIDES FOR THE TREATMENT OF SYSTEMIC LUPUS ERYTHEMATOSUS

of which the following is a full, clear and exact description.

PEPTIDES FOR THE TREATMENT OF SYSTEMIC LUPUS ERYTHEMATOSUS AND METHODS OF TREATING SYSTEMIC LUPUS ERYTHEMATOSUS

This application is a continuation-in-part of and claims benefit of U.S. Serial No. 09/339,494, filed September 20, 1999, which is a continuation of PCT International Application No. PCT/IB98/00415, filed March 20, 1998, designating the United States of America, which claims priority of Israeli Application No. 120503, filed March 20, 1997, the contents of which are incorporated by reference into the present application.

FIELD OF THE INVENTION

This invention relates to the use of laminin peptides and laminin derivatives, including R38 peptide and related analogs for the treatment and detection of systemic lupus erythematosus. This invention also provides methods of treating systemic lupus erythematosus.

BACKGROUND OF THE INVENTION

Systemic lupus erythematosus (SLE) is an autoimmune disease involving multiple organs. Through the involvement of the kidneys in the autoimmune inflammatory process, lupus glomerulonephritis is a major cause of morbidity and mortality in this disease (Alarcon-Segovia D. in: Primer on the Rheumatic Diseases. Ed. Schumascher, H.R. Arthritis Foundation, Atlanta, Georgia (1988) pp. 96-100).

Serologically, the disease is characterized by the occurrence of a variety of autoantibodies in the serum, of which the most prominent are the anti-DNA auto antibodies (Naparstek Y., et al., Ann. Rev. Immunol. (1993), 11, 79-104). Although low titers of anti-DNA antibodies may occur in various inflammatory and autoimmune diseases, high levels are found mainly in SLE, and the combination of high anti-DNA antibodies with low complement levels is virtually diagnostic of SLE (Wallace, D.J. et al. in: Dubois' Lupus Erythematosus, Lea and Febiger, Philadelphia, (1993)).

The binding of immunoglobulins to the glomerular basement membrane (GBM) has been shown by the staining of kidneys derived from lupus patients or lupus stains of mice (Wallace, D.J. et al., *supra*). It has also been shown that anti-DNA antibodies

eluted from the kidneys of a lupus patient as well as from MRL/1pr/lpr mice cross-react with sulfated glycosaminoglycans whereas the serum anti-DNA antibodies do not show this cross- reactivity (Naparstek, Y., et al., Arthritis Rheum. (1990), 33, 1554-1559). These results have suggested that extracellular matrix (ECM) plays a role in the pathogenesis of lupus as the target for the nephritogenic autoantibodies.

Termmat R.M. et al. disclose the cross-reaction of components of the ECM, like laminin and heparin with murine monoclonal anti-DNA antibodies. (J. Autoimmun. (1990), 3, 531-545.)

European Patent Application 670,495 discloses the presence of anti-ECM antibodies in the urine of patients with active lupus. Furthermore, EP 670,495 discloses the cross-reaction of these antibodies with a 200 kDa laminin component of the ECM, and an assay for SLE based on the detection of these anti-ECM/laminin antibodies in urine.

R38 is a peptide sequence isolated from the C-terminal region of the mouse laminin ∝ chain (residues 2890-2910 according to Skubitz et al., J. Cell. Biol. (1991), 115, 1137-1148, or residues 2851-2871 according to Sasaki, M. et al., J. Biol. Chem. (1998), 263, 16, 536-16, 544). It is located at the junction of the globular domains of the fourth and fifth loops (peptide GD-2 in Skubitz et al., *supra*, and is comprised of the following amino-acid sequence:

KEGYKVRLDLNITLEFRTTSK (SEQ. ID. NO. 1)

Current SLE therapy is limited to corticosteroids which suppress the over-reactive immune system. This therapy is not specific and its inevitable side effects may themselves be fatal. Furthermore, immunosuppressive therapy is complicated and its initiation is based on a combination of clinical symptoms, blood serological test and kidney biopsy. There is, therefore, a need for a more specific therapy for SLE that will not have the side effects of immunosuppresive agents, as well as a more specific and less invasive assay for the evaluation of disease activity. Indeed, a recent review (The Lancet (1995), 310, 1257-1261) stated that blood tests, though useful in confirming diagnosis of SLE, are "less useful in monitoring disease activity."

None of the above-mentioned references disclose the treatment of SLE by the administration of the R38 peptide or analogs thereof. Moreover, none of the above-

mentioned references disclose the use of R38 peptide in a diagnostic test for SLE or in monitoring SLE disease activity. The contents of all these patents and all literature references referred to above are hereby incorporated by reference in their entirety.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a method for treating systemic lupus erythematosus comprising the administration of laminin peptides.

Another object of the present invention is to provide a method of treating SLE comprising the extracorporeal removal of anti-R38 (and derivatives thereof) antibodies from a subject's plasma and returning the plasma to the subject.

Yet another object of the present invention is to disclose R38' and other novel analogs and derivatives of the R38 peptide, the administration of which comprises a method for treating SLE.

A further object of the present invention is to provide a diagnostic test for SLE by using the R38 peptide, R38' peptide and other structurally related analogs and derivatives thereof.

The invention also relates to pharmaceutical compositions comprising the R38 peptide, R38' peptide and other novel analogs and derivatives of the R38 peptide, or pharmaceutically acceptable salts thereof for use in the treatment of SLE.

As used herein, the term, "R38 peptide", is used to include the R38 peptide itself, analogs, derivatives and fragments thereof that retain the activity of the complete peptide. The term, "analogs", is intended to include variants on the peptide brought about by, for example, homologous substitution of individual or several amino acid residues. The term, "derivative", is used to include minor chemical changes that may be made to R38 itself or analogs thereof that maintain the biological activity of R38 and similarly, the term, "fragments", is used to include shortened molecules of R38.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows the direct binding of C72 murine anti-DNA antibody to laminin peptides;

Figure 2 shows the inhibition by R38, 5200, DNA, DNase and heparin of the binding of C72 to the R38 analog 5200 (sometimes referred to herein as R38');

Figures 3 and 4 show the binding of the human lupus monoclonal anti-DNA antibodies (DIL6 and B3) to laminin peptides and derivatives thereof;

Figures 5, 6 and 7 show the correlation between lupus activity score and urinary anti-R38 level in three lupus patients;

Figure 8 shows the effect of 5200 (R38') treatment on the prolongation of survival of lupus mice;

Figure 9 shows the effect of R38 (also referred to herein as 5100) treatment on the prolongation of survival of lupus mice.

Figure 10 shows the inhibition of C72 binding to R38 (5100) by DNA and by R38 analogs.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Accordingly, the present invention relates to the use of laminin peptides for the treatment of systemic lupus erythematosus.

The present invention is based on the observation that the R38 peptide, which is a peptide derived from the C-terminal region of the mouse laminin $\propto$ chain, is recognized by pathogenic lupus antibodies and may therefore possess therapeutic potential in the treatment of SLE by competing in the binding to the lupus antibodies.

Furthermore, the present invention relates to the use of a mixture of at least two or more different peptides derived from laminin for the treatment of systemic lupus erythematosus. In a preferred embodiment, at least one of the peptide is R38 or an

analog thererof.

The present invention also provides methods of treating a subject having SLE by the extracorporeal removal of lupus antibodies (anti-R38 and derivatives thereof) from a subject's plasma and returning the plasma to the subject. In one embodiment, the antibodies are removed by column chromatography wherein at least one type of peptide is adsorbed to the column. In a further embodiment, the column is adsorbed with two or more types of peptides. In another embodiment, the peptide is selected from the group consisting of SEQ. ID. NO. 1-22. In a further embodiment, the peptide has SEQ. ID. NO. 1. In yet another embodiment, the peptide has SEQ. ID. NO. 10. In one embodiment, the column is a NHS-activated Sepharose™ High Performance Column.

The invention also relates to a method of monitoring disease activity of patients suffering from SLE, comprising detecting the ability of the antibodies in the urine to bind to the R38 component of the laminin. This binding can have a direct correlation to disease activity evaluated by a combination of various laboratory parameters.

An increase in the amount of antibodies binding to R38 may indicate an approaching active phase of SLE and a declining level of antibodies may indicate an approaching remission. Therefore, this method provides an assay for detecting changes in the level of laminin-specific antibodies and may enable the initiation of therapy prior to the onset of an active phase of the disease.

This method also provides an easy assay that can be used by the patients themselves as it is performed using urine and does not require venipuncture. It may be used as a diagnostic assay, a routine assay for evaluation of SLE disease activity, for early identification of disease exacerbation and for early therapeutic intervention in lupus nephritis.

The R38 peptide or analogs, fragment or derivatives thereof may be used in such an assay using the methods described in EP 670, 495. Thus, the R38 peptide may be bound to a solid phase and incubated with the urine from a patient. If the patient is suspected of suffering from SLE, suffering from SLE or is approaching an active phase of the disease, the level of R38-binding antibodies in the urine will increase.

Detection of R38-binding antibodies may be undertaken by any method known by one

skilled in the art. Examples of such methods of detection include ELISA and variations thereon, chemiluminescent techniques, etc. The actual method of detection is not crucial to the success of the assay. The level of R38-binding antibodies observed may then be compared to values observed in a control group. The control group may consist of healthy volunteers, or the patient may act as an internal control i.e., the observed value is compared to an earlier value from the same patient. In this manner, a profile of the patient's disease state may be complied and uses as an indicator of further active phases or remission states of the disease.

Pharmaceutically acceptable salts of the R38 peptide include both salts of the carboxy groups and the acid addition salts of the amino groups of the peptide molecule. Salts of the carboxy groups may be formed by methods known in the art and include inorganic salts such as sodium, calcium, ammonium, ferric or zinc salts and the like and salts with organic bases such as those formed with amines such as triethanolamine, arginine or lysine, piperidine, procaine and the like. Acid addition salts include salts with mineral acids such as hydrochloric acid and sulphuric acid and salts of organic acids such as acetic acid and oxalic acid.

The pharmaceutical composition may contain laminin peptides such as the R38 peptide as unique peptides or in polymerized or conjugated forms attached to macromolecular carriers or polymers. The composition may optionally contain pharmaceutically acceptable excipients. In an alternative embodiment, the composition may contain the R38 peptide alone.

The route of administration may include oral, intra-venous, intra-peritoneal, intra-muscular, subcutaneous, intra-articular, intra-nasal, intra-thecal, intra-dermal, trans-dermal or by inhalation.

An effective dose of the R38 peptide or derivatives thereof for use in treating SLE may be from about 1 μg/kg to 100mg/kg body weight, per single administration, which may be easily determined by one skilled in the art. The dosage may depend upon the age, sex, health and weight of the recipient, kind of concurrent therapy, if any, and frequent of treatment.

EXAMPLES

GENERAL

The Peptides

Peptides R26, R28, R30, R31, R35, R37, and R38 (also referred hereinafter as "5100" and "TV 5100") derived from the C-terminal of mouse laminin ∝ chain, and the R18 peptide derived from the N-terminal of mouse laminin ∝ chain were tested. The peptides are 17-22-mer synthetic peptides, and were prepared by the F-moc technique (Carpino, L.A. & Han, G.Y. (1972), J. Org. Chem., 37, 3404). These peptides could also be produced by methods well known to one skilled in the art of biotechnology. For example, using a nucleic acid selected from the group including DNA, RNA, cDNA, genomic DNA, synthetic DNA, mRNA, total RNA, hnRNA, synthetic RNA, the desired peptides may be produced in live cell cultures and harvested. The sequences of the peptides are presented in the Table 1.

Table 1: Laminin Derived Peptides.

PEPTIDES	RESIDUES (*)	SEQUENCE
R18	42-63	RPVRHAQCRVCDGNSTNPRERH (SEQ. ID. NO. 2)
R26	2443-2463	KNLEISRSTFDLLRNSYGVRK (SEQ. ID. NO. 3)
R35	2547-2565	TSLRKALLHAPTGSYSDGQ (SEQ. ID. NO. 4)
R37	2615-2631	KATPMLKMRTSFHGCIK (SEQ. ID. NO. 5)
R28	2779-2795	DGKWHTVKTEYIKRKAF (SEQ. ID. NO. 6)
R38	2890-2910	KEGYKVRLDLNITLEFRTTSK (SEQ. ID. NO. 7)
R30	3011-3032	KQNCLSSRASFRGCVRNLRLSR (SEQ. ID. NO. 8)

(*) Residue designations per Skubitz, *supra*.

Other laminin peptides used for comparative purposes in the Examples include AS31 (comprising the residues YIGSR), AC15 and F9 (other laminin peptides) and R27 a peptide from the 4th loop of the globular region of the laminin α chain.

Additional peptides which are fragments of, or analogs closely derived from R38 have been constructed and are presented in Table 2 hereinbelow. Peptides 5200 and 5101-5111 disclosed in Table 2 were prepared in the same manner as the peptides of Table 1 hereinabove. The Table 2 peptides comprise R38 (5100), human R38 (5300), fragments of R38, a fragment 5111 derived from 5300 or analogs of R38 wherein one or more point substitutions were made according to techniques which are well known to one skilled in the art. These peptides were constructed to investigate, among other things, the effect on anti-DNA antibody binding activity caused by changing the net charge of the R38 peptide.

TABLE 2 - Synthetic Peptides Analogous To Mouse R38 Peptide

Peptide #	AMINO ACID SEQUENCE	DESCRIPTION	Net Charge
5100	KEGYKVRLDLNITLEFRTTSK (SEQ ID NO. 9)	Mouse R38	+2
5200	KEGYKVRLDLNTTLEFRTTSK (SEQ ID NO. 10)	Mouse R38 analog	+2
5300	KEGYKVQSDVNITLEFRTSSQ (SEQ ID NO. 11)	Human R38	0
5101	KEGYKVRLDLNITLEF (SEQ ID NO. 12)	Res. 1-16 of 5100	0
5102	VRLDLNITLEFR (SEQ ID NO. 13)	Res. 6-17 of 5100	0
5103	LDLNITEFRTTSK (SEQ ID NO. 14)	Res. 8-21 of 5100	0
5104	AEGYAVALDLNITLEFATTSA (SEQ ID NO. 15)	Ala subst. of 5100 at all positive a.a	-3
5105	KEGYKVELDLNITLEFETTSK (SEQ ID NO. 16)	charge subst. to neg. at 5100 a.a. 7 and 17	-2
5106	KEGYKVELDLNITLEFRTTSK (SEQ ID NO. 17)	charge subst. to neg. at 5100 a.a. 7	0
5107	KEGYKVRLDLNITLEFETTSK (SEQ ID NO. 18)	charge subst. to neg. at 5100 a.a. 17	0
5108	KAGYKVRLALNITLAFRTTSK (SEQ ID NO. 19)	Ala subst. of 5100 at all negative a.a.	+5
5109	KEGYKVRLALNITLEFRTTSK (SEQ ID NO. 20)	Ala subst. of 5100 a.a. 9	+3
5110	KEGYKVRLDLNITLAFRTTSK (SEQ ID NO. 21)	Ala subst. of 5100 a.a. 15	+3
5111	VQSDVNITLEFR (SEQ ID NO. 22)	Res. 6-17 of 5300	-1

a.a. Amino Acid

Monoclonal Antibodies

The C72 murine anti-DNA antibody has been derived from (NZBxNZW)F1 lupus mice by the hybridoma technique as described in Eilat D. et al J. Immunol. (1991) 147 361-368. The monoclonal anti-DNA antibodies DIL6 and B3 were derived from lupus patients by hybridoma technique as described in Ehrenstein M.R. et al J. Clin. Invest. (1994) 93 1787-1799 and Ehrenstein M.R. et al Kidney Inter. (1995) 48 705-711.

It should be understood that the following description contemplates use of antibodies specific to the laminins and to the peptides disclosed herein. Methods for producing peptides specific to the laminin peptides and to R38 and its analogs and derivatives are well known to one skilled in the art. In this regard, specific reference may be had to the text "Antibodies, A Laboratory Manual," Ed Harlow and David Lane, Cold Spring Harbor Publishing, 1988, the contents of which are incorporated herein by reference. This reference discloses methods which may be used for obtaining monospecific antibodies, i.e., monoclonal antibodies and polyclonal antibodies directed against laminin peptides.

Anti-Peptide (Direct Binding) ELISA:

Wells were coated with 10 µg/ml of the peptides, blocked with 1% BSA (bovine serum albumin) in PBS (pH 7,4), reacted with appropriately diluted serum or urine samples or monoclonal antibodies, incubated with anti-human or anti-mouse immunoglobulin enzyme conjugated to alkaline phosphatase and detected by addition of substrate (Sigma 100 Phosphatase Substrate Tablets) and color development using an Organon Teknika Microwell System spectrometer at wavelength of 405nm.

Competitive Inhibition Assays:

In competitive inhibition assays, the antibodies were incubated with various concentrations of the inhibitor (for example: peptide, DNA, heparin) or with DNase

for 45 minutes at room temperature and the remaining binding was then evaluated by ELISA as described heretofore.

% inhibition was computed as:

$$\frac{\text{O.D. binding without inhibitor - O.D. binding with inhibitor}}{\text{O.D. binding without inhibitor}} \times 100 = \% \text{ inhibition}$$

EXAMPLE 1: Binding of Laminin Peptides To SLE Antibodies

A: Murine SLE antibodies bind to C terminal peptides of laminin α chain.

The interaction of the C72 murine anti-DNA antibody with laminin peptides was analyzed by ELISA as described above. The C72 conditioned medium was diluted in PBS in various dilutions. The results are summarized in Figure 1 which shows the binding of C72 murine anti-DNA antibody to the 5200, R37, and R30 peptides, but not to R28 or R18 peptides of the laminin α chain. Control murine antibody, the anti-HEL Hy5 did not bind to the 5200 peptide (data not shown).

B: Inhibition of the binding of C72 to 5200 is inhibited by DNA and Heparin

The binding of C72 to 5200 was tested before and after incubation with 5200, R38, R18, Heparin, DNA and DNase. The results are summarized in Figure 2 which shows the inhibition of the binding of C72 to 5200 by the R38 or 5200 peptides of the present invention, by DNA and by heparin, but not by a control peptide or treatment with DNase. The percent inhibition is the percent reduction of the O.D. after incubation with the inhibiting agent.

EXAMPLE 2: Polyclonal Murine Antibodies Bind To The 5200 Peptide

Analysis of the interaction of MRL/lpr/lpr urine antibodies with the 5200 peptide by a direct binding ELISA revealed specific binding. Thus, pooled urine from at least 5

mice (either MRL/lpr/lpr or control mice, e.g. BALB/c) was added to wells coated with R38' (5200), R18 or DNA as described above and bound 5200 assayed by ELISA.

Binding Of Murine Urinary Immunoglobulins To 5200

Each group is comprised of pooled urine.

MICE	ANTIGEN		
	DNA	5200	R18
BALB/c	U.D.	U.D.	U.D.
MRL/lpr/lpr	U.D.	0.26 (*)	U.D.

U.D. - Undetected

(*) O.D. at 405 nm.

EXAMPLE 3: Human Monoclonal Lupus Antibodies Bind The 5200 Peptide

The human monoclonal anti-DNA antibodies DIL 6 and B3 were derived from lupus patients by the hybridoma technique. As shown in Figures 3 and 4 these antibodies were found to bind to the 5200 peptide but not to other laminin peptides tested. In Figures 3 and 4, the peptides are referred to as denoted above or as follows; AS30 is R27, AS19 is R35, AS35 is R26, AS17 is R28 and AS6 is R18.

EXAMPLE 4: Effect Of R38 (5100) & R38' On The Clinical Course Of Murine SLE

To test whether R38 peptides can affect the course of SLE we have tested their effect on MRL/lpr/lpr mice disease. 60µg of 5200 (R38' alone or in peptide combinations, 30µg of each) in 0.1ml PBS, was injected i.p. to 6 week old female MRL/lpr/lpr mice once a week for 16 weeks and the mice were evaluated for survival (Fig. 8), and for renal histology.

50µg of 5100 (R38) or 5300 (human R38) in 0.1ml PBS, was injected i.p. to 6 week old MRL/1pr/1pr mice three times a week and the mice were evaluated for survival (Figure 9), and for renal histology. Control mice received 0.1ml phosphate buffer solution. Each test and control group contained 12 - 15 mice.

The survival of MRL/1pr /1pr mice treated with 5100, 5200 or 5300 was compared to that of PBS treated mice. As shown in Figures 8 and 9, the survival of mice treated with 5100 or 5200 was significantly higher than that of control mice. In Figures 8 and 9 the time in days shown on the x axis relates to the age of the mice. Two mice in each group were sacrificed after 5 months.and their kidneys evaluated by light microscopy The kidneys from the control mice showed severe diffuse proliferative glomerulonephritis with crescents and sclerosis whereas the 5100 or 5200 treated mice showed mild proliferative changes with no crescents and no sclerosis.

EXAMPLE 5 -Analysis of the Correlation between Anti- R38 Antibodies and Disease Activity

Urine from lupus patients with and without renal disease in active and inactive state were collected repeatedly and tested for presence of anti-R38 antibodies by ELISA. Activity of the disease was evaluated also by accepted clinical and serological parameters (Lockshin M.D. et al Am. J. Med. (1984) 77 893-898) and their correlation with anti-R38 levels was compared.

103 urine samples of 37 SLE patients were tested for anti-R38 activity by ELISA as described above. 23 of the samples were from patients without renal disease and 80 samples from patients with renal disease. A further 12 samples from patients with renal disease not relates to SLE were also included

The following results were obtained:

SLE	Present	Present	Absent
Renal Disease	Absent	Present	Present
No. Samples	23	80	12
Urine anti-R38 O.D. (Mean+S.E.)	0.035±0.003	0.229±0.03*	0.07±0.01

*p<0.001

Positivity of the samples in those patients with renal disease usually correlated with active disease according to an activity score that includes 19 clinical and laboratory parameters (Lockshin M.D. et al supra). These parameters included assessment of the presence/absence/condition of the following clinical criteria alopecia, rash, fever, serositis, athralgia/arthritis, mucosal ulcers, neurological events, malaise, fundi changes, nodes, spleen and the following blood tests including ESR (erythrocyte sedimentation rate), anti DNA antibodies, complement (U/ml), creatinine, haemoglobin (g/dl), PLT platelets (/mm^2) or urinalysis. The assessment of these parameters is measured as described in Lockshin supra. The overall percentage given reflects only the assessed parameters.

In some patients urine samples were tested in more than one occasion and a good correlation between the clinical activity and the level of anti R38 binding were observed. Three representative examples from three different lupus patients are shown in Figures 5,6 and 7 where the x-axis shows the No. of the hospital visit and the y-axis, the observed binding (OD at 405nm) or percentage of the activity score described above. As can be seen from these Figures, the assay using the R38 peptide provides a reliable method of monitoring disease activity.

EXAMPLE 6 - Analysis of the Correlation Between anti-5200 (R38') Antibodies and Disease Activity.

In an additional experiment, 178 urine samples from lupus patients, 24 with and 22 without renal disease in active and inactive state were collected and tested for

presence of anti-5200 antibodies by ELISA as described above. The following results were obtained:

Renal Disease	Absent	Present
No. Samples	46	132
Urine anti-5200 O.D. (Mean+S.E.)	0.05±0.005	0.335±0.035*

*p<0.001

EXAMPLE 7 - Analysis of the Correlation Between anti-5100 (R38) Antibodies and Disease Activity.

45 urine samples from 21 lupus patients, some with and some without renal disease in active and inactive state were collected and tested for presence of anti-5100 antibodies by direct ELISA as described above.

The following results were obtained:

Renal Disease	Absent	Present
No. Samples	6	39
Urine anti-5100 O.D. (Mean+S.E.)	0.058±0.006	0.376±0.05*

*p<0.03

EXAMPLE 8 - Analysis of the Correlation Between anti-5200 (R38') Antibodies and Disease Activity.

52 urine samples from 21 lupus patients, with and without renal disease in active and inactive state were collected and tested for presence of anti-5200 antibodies by ELISA as described above.

The following results were obtained:

Renal Disease	Absent	Present
No. Samples	6	46
Urine anti-5200 O.D. (Mean+S.E.)	0.052±0.03	0.431±0.09

EXAMPLE 9 - Analysis of the Correlation Between Anti -5108, 5101, 5109 and 5110 - Antibodies and Disease Activity

24 urine samples from some of the lupus patients of Examples 7 and 8, 2 with and 22 without renal disease in active and inactive state were collected and tested for binding to 5108 peptides by ELISA as described above.

The following results were obtained:

Renal Disease	Absent	Present
No. Samples	2	22
Urine anti-5108 O.D. (Mean+S.E.)	0.064±0.05	0.672±0.1

Similar results were observed for binding of peptides 5101, 5109 and 5110.

EXAMPLE 10 - Direct Binding Of C72 And B3 To R38 And Analog Peptides

The peptides of the present invention were tested for their ability to bind directly with C72 murine anti-DNA antibodies and B3 human anti-DNA antibodies according to the method described hereinabove. The results of the direct binding study are reported in Table 3:

Table 3 - Direct Binding Of C72 And B3 To R38 And Analog Peptides

Peptide #	C72 Binding†	B3 Binding‡
5100	2.57	0.9
5200	1.6	0.25
5300	0.03	0.03
5101	1.11	0.1
5102	0.1	0.02
5103	0.03	0.02
5104	0.06	0.02
5105	0.07	0.02
5106	1.9	0.16
5107	0.05	0.01
5108	2.75	1.93
5109	2.72	1.94
5110	2.8	1.83
5111	0.01	0.01
R18	0.01	NT*
R28	0.01	NT
R30	0.75	NT
R37	1.8	NT

*NT - Not Tested

† - O.D. in a direct binding ELISA test after one (1) hour.

‡ - O.D. in a direct binding ELISA test after two (2) hours.

EXAMPLE 11: Competitive Inhibition Of C72 Binding To R38 With Analog Peptides

A competitive inhibition study compared how each of the peptides competes with R38 (5100) for binding to the C72 anti-DNA antibody. Conducted according to the methods described hereinabove, the results of the study are disclosed in Table 4 below and are further elucidated by reference to Fig. 10.

Table 4: Inhibition of C72 Binding to R38

Peptide #	50% Inhibition of C72 binding to mouse R38 (5100) in ug/ml*
5100	10
5200	10
5300	85
5101	5
5102	30
5103	NI**
5104	NI
5105	NI
5106	2.5
5107	85
5108	2
5109	0.7
5110	0.7
5111	NI

* - Concentration of competitive inhibitor which resulted in 50% inhibition of the binding of C72 anti-DNA antibody to peptide 5100 (R38) in an ELISA test.

**NI - No Inhibition

5

Example 12: Immunoabsorption of SLE Antibodies on a Column

This example demonstrates the use of a column for extracorporeal removal of anti-R38(TV-5100) (and derivatives thereof) pathogenic lupus antibodies from a subject's blood.

Preparation of the Column

The R38 peptide was dissolved in the coupling buffer (0.2M $NaHCO_3$, 0.5M NaCl, pH 8.3) in a concentration of 1 mg/ml in 5 ml coupling buffer. A 5 ml N-hydroxysuccinimide (NHS)-activated Sepharose™ High Performance Column (Pharmacia 17-0717-01) is used. The isopropanol in the column was washed out from the column with 30 ml of cold (4 °C) 1 mM HCl and 5 ml of the peptide solution was then injected onto the column with a syringe (2.5 ml/minute). The column was sealed and stood for 30 minutes at room temperature. The column was then washed with 30 ml Buffer A (0.5 M ethanolamine, 0.5 M NaCl, pH 8.3) and 30 ml Buffer B (0.5 M acetate, 0.5 M NaCl, pH 4) consecutively three times, and then with neutral pH buffer (0.05 M Na_2HP0_4 and 0.1% NaN_3).

Affinity Absorption of the Anti-R38 (TV-5100) Antibodies

The column was washed with 15 ml PBS (phosphate buffered saline), followed by 15 ml elution buffer (0.1 M glycine HCl) and then 50 ml PBS. The C72 antibody or the patients' plasma samples were filtered through a 0.45 microm filter. The samples were applied onto the column by a fitted syringe at a rate of 2.5 ml/min. The column was then washed with 5 ml PBS and the flow-through was applied to the column again. The binding of the samples (original and flow-through) to R38 was tested by the anti-R38 ELISA test.

In the instant example, the mouse C72 and the SLE patients' plasma were applied to the R38 column. Their anti-R38 binding was evaluated by ELISA in the original samples and in the flow-through of the column.

As shown in Table 5, affinity absorption on the column removed 99% of the anti-R38 activity of the mouse monoclonal C72 and between 30%-60% of the antibodies in the human SLE patients' plasma.

Table 5: Affinity Absorption

Sample	Binding to R38 (O.D.)	
	Original sample	After immunoabsorption
C72	1.96	0.02
SLE patient 1 plasma	1.5	0.6
SLE patient 2 plasma	2.3	1.6
Healthy donor's plasma	0.26	0.06

Thus, SLE may be treated by affinity absorption of a SLE patient's plasma and returning the plasma to the patient intravenously.

It should be understood that the foregoing description and examples are merely illustrative and that many modifications and variations may be made thereto by one skilled in art without departing from the scope and spirit of the invention as claimed hereinbelow.